

PUBLIC UTILITIES COMMISSION

505 VAN NESS AVENUE

SAN FRANCISCO, CA 94102-3298



April 30, 2009

**Advice Letter 3239-E**

Brian K. Cherry  
Vice President, Regulatory Relations  
Pacific Gas and Electric Company  
77 Beale Street, Mail Code B10C  
P.O. Box 770000  
San Francisco, CA 94177

**Subject: Proposed Plan for 5% Accuracy Certification Requirements  
and Testing Procedures for Inverter-Integrated Meters**

Dear Mr. Cherry:

Advice Letter 3239-E is effective April 28, 2008.

Sincerely,

A handwritten signature in blue ink, appearing to read "Julie A. Fitch".

Julie A. Fitch, Director  
Energy Division

March 28, 2008

**Advice 2227-E**

(Southern California Edison Company ID U 338-E)

**Advice 3239-E**

(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

**Subject: Proposed Plan for 5% Accuracy Certification Requirements and Testing Procedures for Inverter-Integrated Meters**

**Purpose**

In compliance with the California Public Utilities Commission (Commission) Decision (D) 07-07-028, Pacific Gas and Electric Company (PG&E), on behalf of the California Solar Initiative (CSI) Program Administrators (PAs), submits the Proposed Plan for 5% Accuracy Certification Requirements and Testing Procedures for Inverter-Integrated Meters (Proposed Plan). The CSI PAs are comprised of PG&E, Southern California Edison Company (SCE) and the California Center for Sustainable Energy (CCSE).

**Background**

In D.06-08-028, the Commission ordered that “all solar projects that receive incentive through the CSI program shall install a separate solar production meter accurate to within 5% for systems under 10 kW.”<sup>1</sup> In D.07-07-028, the Commission modified this requirement to “require all systems taking incentive under the EPBB to have meters that are accurate within  $\pm 5\%$  of the actual system output.”<sup>2</sup> Furthermore, the Commission ordered the PAs, working with the CSI Metering Subcommittee, to “investigate and develop a plan to ensure the accuracy level of  $\pm 5\%$  meters used to report output from systems receiving CSI incentives under the EPBB program.”<sup>3</sup>

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<sup>1</sup> D.06-08-028, Ordering Paragraph 16, page 124.

<sup>2</sup> D.07-07-028, Page 7, second paragraph.

<sup>3</sup> D.07-07-028, Ordering Paragraph 3, page 12.

### **Proposed Meter Certification Plan**

This advice filing represents the work of the 5% Meter Certification Working Group (Working Group). The Working Group, comprised of members of the CSI Metering Subcommittee, includes a cross section industry stakeholders, including CPUC's Energy Division, California Energy Commission (CEC), PG&E, SCE, CCSE, Benke Erdman and Whitaker (BEW) Engineering, SunEdison, SolarCity, SunPower Corporation, Fat Spaniel Technologies, Veris Industries, TriMark Associates, Enphase Energy, PV Powered, SMA America, Integrated Metering Systems, Sacramento Municipal Utilities District (SMUD) and Continental Control Systems.

The Working Group met many times over the past nine months to develop the Proposed Plan. The Proposed Plan is based on existing certification requirements for utility-grade meters, adjusted to the 5% accuracy level required under the CSI program. The Working Group recommends the requirements set forth in the Proposed Plan be mandatory for all systems participating under the CSI Expected Performance Based Buydown (EPBB) incentive program effective July 1, 2009. This will give manufacturers time to develop metering devices able to meet this new requirement, as well as Nationally Recognized Testing Laboratories time to develop testing and certification procedures.

In the interim period, manufacturers may voluntarily meet these requirements and be listed on the CEC Eligible Equipment List. It is further recommended that these requirements be proposed for adoption as a national or international standard for inverter-integrated meters by a recognized Standards Setting Organization. To achieve this goal, the Working Group recommends that the Commission direct one of the PAs to hire a technical consultant experiencing in standards development to manage this process. The Working Group recommends that the CEC be responsible for owning and managing the interim requirements until a standard is developed and adopted.

### **Protests**

Anyone wishing to protest this filing may do so by letter sent via U.S. mail, by facsimile or electronically, any of which must be received no later than **April 17, 2008**, which is 20 days after the date of this filing. Protests should be mailed to:

CPUC Energy Division  
Tariff Files, Room 4005  
DMS Branch  
505 Van Ness Avenue  
San Francisco, California 94102

Facsimile: (415) 703-2200  
E-mail: [anj@cpuc.ca.gov](mailto:anj@cpuc.ca.gov) and [mas@cpuc.ca.gov](mailto:mas@cpuc.ca.gov)

Copies of protests also should be mailed to the attention of the Director, Energy Division, Room 4004, at the address shown above.

The protest also should be sent via U.S. mail (and by facsimile and electronically, if possible) to PG&E at the address shown below on the same date it is mailed or delivered to the Commission:

Brian K. Cherry  
Vice President, Regulatory Relations  
Pacific Gas and Electric Company  
77 Beale Street, Mail Code B10C  
P.O. Box 770000  
San Francisco, California 94177

Facsimile: (415) 973-7226  
E-mail: [PGETariffs@pge.com](mailto:PGETariffs@pge.com)

### **Effective Date**

PG&E requests that this advice filing become effective on regular notice, **April 28, 2008**, which is 31 calendar days after the date of filing.

### **Notice**

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically and via U.S. mail to parties shown on the attached list and to the service list for R.08-03-008. Address changes to the General Order 96-B service list should be directed to Rose de la Torre at (415) 973-4716. Advice letter filings can also be accessed electronically at: <http://www.pge.com/tariffs>

A handwritten signature in cursive script that reads "Brian K. Cherry / dc".

Vice President, Regulatory Relations

Attachments

cc: Service List R.08-03-008

# CALIFORNIA PUBLIC UTILITIES COMMISSION

## ADVICE LETTER FILING SUMMARY ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No. **Pacific Gas and Electric Company (ID U39 M)**

Utility type:

ELC

GAS

PLC

HEAT

WATER

Contact Person: Daren Chan

Phone #: (415) 973-5361

E-mail: D1CT@pge.com

### EXPLANATION OF UTILITY TYPE

ELC = Electric

GAS = Gas

PLC = Pipeline

HEAT = Heat

WATER = Water

(Date Filed/ Received Stamp by CPUC)

Advice Letter (AL) #: **2227-E (SCE), 3239-E (PG&E)**

**Tier: 2**

Subject of AL: Proposed Plan for 5% Accuracy Certification Requirements and Testing Procedures for Inverter-Integrated Meters

Keywords (choose from CPUC listing): CSI Program

AL filing type:  Monthly  Quarterly  Annual  One-Time  Other \_\_\_\_\_

If AL filed in compliance with a Commission order, indicate relevant Decision/Resolution #: D.07-07-028

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL: No

Summarize differences between the AL and the prior withdrawn or rejected AL<sup>1</sup>: \_\_\_\_\_

Is AL requesting confidential treatment? If so, what information is the utility seeking confidential treatment for: No

Confidential information will be made available to those who have executed a nondisclosure agreement:  Yes  No

Name(s) and contact information of the person(s) who will provide the nondisclosure agreement and access to the confidential information: \_\_\_\_\_

Resolution Required?  Yes  No

Requested effective date: **April 28, 2008**

No. of tariff sheets: N/A

Estimated system annual revenue effect (%): N/A

Estimated system average rate effect (%): N/A

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: N/A

Service affected and changes proposed<sup>1</sup>: N/A

Pending advice letters that revise the same tariff sheets: N/A

Protests, dispositions, and all other correspondence regarding this AL are due no later than 20 days after the date of this filing, unless otherwise authorized by the Commission, and shall be sent to:

**CPUC, Energy Division**

**Tariff Files, Room 4005**

**DMS Branch**

**505 Van Ness Ave.,**

**San Francisco, CA 94102**

**jnj@cpuc.ca.gov and mas@cpuc.ca.gov**

**Pacific Gas and Electric Company**

**Attn: Brian K. Cherry**

**Vice President, Regulatory Relations**

**77 Beale Street, Mail Code B10C**

**P.O. Box 770000**

**San Francisco, CA 94177**

**E-mail: PGETariffs@pge.com**

**Proposed Plan For**  
**5% Accuracy Certification Requirements and Testing Procedures**  
**for Inverter-Integrated Meters**

**March 28, 2008**

Introduction

In August 2006, the California Public Utilities Commission (CPUC) established the California Solar Initiative (CSI) program to support the sustainable development and deployment of solar technologies and systems throughout California. In keeping with the goals of the CSI program, the CPUC recognized the need to set requirements for metering the output of solar systems. The CPUC further recognized that different levels of meter accuracy are appropriate for different system sizes and incentive categories. Accordingly, electricity metering accuracy levels of  $\pm 2\%$  for systems participating under the Performance Based Incentive (PBI) structure and  $\pm 5\%$  for systems participating under the Expected Performance Based Buydown (EPBB) incentive structure were established.

In Decision (D) 07-07-028, the CPUC directed the CSI Metering Subcommittee, reporting to the three Program Administrators<sup>1</sup> to develop a plan to ensure the accuracy level of  $\pm 5\%$  meters used to report output from systems receiving CSI incentives under the EPBB structure. Shortly thereafter, the 5% Meter Certification Working Group<sup>2</sup> (Working Group) was formed to accomplish this task.

Background

The Working Group determined that the most equitable and effective means for ensuring the accuracy of  $\pm 5\%$  meters was to model the certification and testing procedures after existing standards and procedures for  $\pm 2\%$  accurate meters, scaled to a  $\pm 5\%$  accuracy level. For this type of meter, testing and certification standards are developed by the National Electrical Manufacturers Association (NEMA) and published by the American National Standards Association (ANSI) as ANSI C12. Meter manufacturers must have each model type tested by a qualified Nationally Recognized Testing Laboratory (NRTL) and certified to the ANSI C12 standard. There are also production line tests performed by the manufacturer on each meter that is manufactured, depending on the specific standards requirement. The NRTL also conducts periodic inspections of the

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<sup>1</sup> The Program Administrators are: Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE) and the California Center for Sustainable Energy (CCSE).

<sup>2</sup> Working Group participants include: CPUC, California Energy Commission, PG&E, SCE, CCSE, Benke Erdman and Whitaker Engineering, SunEdison, SolarCity, SunPower Corporation, Fat Spaniel Technologies, Veris Industries, TriMark Associates, Enphase Energy, PV Powered, SMA America, Integrated Metering Systems, Sacramento Municipal Utilities District and Continental Control Systems.

manufacturer's facility to ensure no changes in hardware or firmware have taken place since the meter model was type-certified.

The Working Group determined that there were two types of meters that would potentially be eligible for the  $\pm 5\%$  certification requirements: panel meters and inverter-integrated meters. After receiving input from panel meter manufacturers, however, it was decided that manufacturers of this type of meter would seek certification under existing ANSI C12 standards for  $\pm 2\%$  meters. Therefore the focus of these requirements is entirely on inverter-integrated meters.

The Working Group started by reviewing the ANSI C12.1-2001 test procedures. Since the focus was on inverter-integrated meters, the Working Group also reviewed existing standards to which inverters are subject, including IEEE 1547, Underwriter's Laboratories (UL) 1741, Federal Communications Commission (FCC) Part 15, and those developed by Sandia National Laboratories (Sandia) and adopted by the California Energy Commission (CEC) for inverter performance. The Working Group determined that an inverter-integrated meter inherently shares the hardware and firmware of an operating inverter to produce AC Power output readings, that these devices will be solid-state devices as opposed to electro-mechanical, and that the meter measurement function is contained within the environmental enclosure of the inverter. Furthermore, while the inverter-integrated meter is capable of displaying and/or transmitting measurement readings, the display, communication equipment and data logging functions may be remote from the inverter.

With these baseline assumptions, each of the 38 ANSI C12.1-2001 tests were evaluated to determine whether it could be applied without change, required modification, or was not applicable. One test was found to be applicable without modification. Twelve tests were found to be not applicable or in conflict with the safe operation of the inverter. The remaining 25 tests were found to overlap or complement requirements of one or more of the existing inverter standards, thereby requiring modification.

The table in Attachment A describes the findings of the Working Group for each ANSI C12.1-2001 test with respect to the applicability for the proposed inverter-integrated testing requirements. Where applicable, the document describes how the test is to be performed and references other standards that may also apply.

To avoid copyright or intellectual property rights violations, the Working Group sent the table with a description of how the certification requirements are intended to be applied to each of the Standards Setting Organizations (SSOs) with proprietary standards that are referenced in the requirements. The Working Group also sent the information to the NRTLs currently qualified to conduct inverter testing and to other recognized experts in standards development for comments and suggestions. As of this writing, NEMA and IEEE have both indicated that the test procedures containing references to each of their respective standards do not violate any copyright or intellectual property rights. We are still waiting to hear from UL to confirm there are no copyright violations, but preliminary discussions with UL staff indicate that there are no such violations.

## Certification Plan

The Working Group proposes that the Commission adopt the attached test procedures for all inverter-integrated meters intended to satisfy the CSI metering requirements under the EPBB incentive structure, consistent with the implementation schedule proposed later in this plan. For the near term, the Working Group further proposes that, with their concurrence, the CEC be responsible for maintaining these requirements and procedures and for qualifying each of the NRTLs to conduct the tests. The CEC will modify their Eligible Equipment List to incorporate the new requirements and indicate which inverter meters have been certified.

Each inverter manufacturer will be responsible for developing inverter-integrated meters designed to comply with these requirements and to engage the services of a qualified NRTL to conduct the certification type-testing. Once the inverter model is certified by the NRTL, the manufacturer will then be responsible for implementing and conducting the appropriate production line tests. The NRTL will conduct periodic inspections of the manufacturer's facility to ensure compliance with these requirements. These inspections will most likely be concurrent with the periodic inspections which are performed as part of the continuing compliance requirements for UL1741 listing.

For the long term, the Working Group recommends that the CPUC direct one of the Program Administrators to engage a technical consultant with expertise in standards development to identify a sponsoring agency and move these requirements to a nationally or internationally recognized standard. The Working Group recommends funding this activity with CSI Administration dollars. Alternatively, the CEC could hire the technical consultant to pursue the development of national or international standards based on these requirements.

The process of establishing a standard is often quite lengthy and could take from 2 to 4 years to complete. However, the Working Group strongly believes that it is essential to the successful development of a sustainable solar industry to have these requirements adopted as standards. This would discourage other states from developing different requirements for this type of meter, which would require manufacturers to develop and market different products in different regions at a significant expense to solar consumers.

## Outreach

For these requirements to be successfully implemented, the Working Group recognizes the need for effective outreach to the inverter manufacturers, SSOs and NRTLs. The Working Group has already made contact with many of the SSOs and NRTLs. The Working Group itself includes several inverter manufacturer representatives, and many others have been made aware of this effort.

The Working Group intends to send this plan, along with the test procedures to all inverter manufacturers currently listed on the CEC's Eligible Equipment List.

Furthermore, the Working Group recommends that the GoSolarCalifornia.com website include information on a webpage that explains these new requirements. The Working Group has identified other channels to distribute information on these requirements as well.

Two members of the Working Group are also on the Solar America Board for Codes and Standards (Solar ABCs) Advisory Board and have recommended that these requirements be incorporated into the Solar ABCs efforts to establish consistent national standards to support solar development. The Working Group is also targeting a meeting of the International Electrotechnical Commission (IEC), Technical Committee 82 (TC 82), scheduled to take place in San Francisco from May 19<sup>th</sup> through 23<sup>rd</sup>. The Working Group intends to have these new requirements discussed at the meeting and has contacted one of the IEC TC 82 US representatives about this effort.

In May or June, PG&E and the Solar Electric Power Association (SEPA) will host a Metering and Performance Monitoring Expo. We will use this opportunity to promote the new requirements and inform manufacturers, distributors, installers and other interested parties of the new requirements. The Working Group is also looking at other outreach opportunities, including other conferences, industry organizations, or possibly hosting a workshop or webinar for industry stakeholders. The group is also exploring opportunities to inform municipal utilities throughout the state of these new requirements.

Once this plan is adopted by the Commission, Working Group members intend to propose changes to the Western Renewable Energy Generation Information System (WREGIS) Operating Rules for metering small systems for Renewable Energy Credit (REC) trading to allow inverter-integrated meters certified to the new requirements. Currently, the Operating Rules require ANSI certified  $\pm 2\%$  accurate meters for all customers. The Working Group believes that modifying the Operating Rules will encourage wide-spread adoption of these new certification requirements. In addition, Working Group members believe allowing residential and small commercial customers to use inverter-integrated meters will encourage more participation in REC trading.

#### Proposed Implementation Timeline

The Working Group has developed the following preliminary timeline for implementing these requirements.

March 28, 2008	Plan Submitted to CPUC
April – June 2008	Work with NRTLs & inverter manufacturers to fine-tune requirements
May 19-23, 2008	IEC TC82 Conference
June 2008	PG&E & SEPA sponsored Metering & Performance Monitoring Expo
July 1, 2008	Requirements & test procedures published
July 1, 2008 – June 30, 2009	Voluntary certification period

July – September 2008	Update GoSolarCalifornia and Program Administrator websites to include information about new inverter meter requirements; explore additional marketing and outreach opportunities
July – August 2008	Test procedures “dry run” with volunteer NRTL & inverter manufacturer
August – September, 2008 September 2008	CEC to qualify NRTLs for certification testing CEC to update Eligible Equipment List to include models from manufacturers who voluntarily meet requirements
July 2008 – June 2009	CEC to work with inverter manufacturers to ensure compliance with new requirements; continued outreach
July 1, 2009	Certification requirements become mandatory for all inverter-integrated meters to be eligible for EPBB
July 2008 – July 2010/2012	Standards development process

This timeline is subject to change as we get additional input from SSOs, NRTLs and manufacturers after they have more opportunity to review the Working Group’s proposal. In particular, until we hear from the NRTLs, we are not sure how long it will take for them to develop the test procedures and prepare to certify the meters.

To ensure both NRTLs and manufacturers have a common understanding of how each test will be performed and how the results will be interpreted for an inverter meter to be certified, the Working Group is proposing conducting a “dry run” of the tests later this summer. The Working Group is seeking at least one NRTL and inverter-integrated meter manufacturer to volunteer to set up the testing process and conduct tests on existing inverter meters. This will provide data for both manufacturers and NRTLs to smoothly transition to the new requirements and to potentially avoid delays and misunderstandings.

Other Issues

The Working Group has identified two additional issues that, while not directly related to the certification of inverter-integrated meters, merit consideration.

First, the requirements described herein address certification of the metering devices prior to the sale and installation of the inverters in the field. More traditional socket style meters used by utilities can be tested to verify their accuracy in the field. Inverter-integrated meters, however, cannot be easily tested once installed. To address potential questions of meter accuracy with these devices after installation, the Working Group investigated and has proposed two methods for field verification of inverter-integrated meter accuracy, included as Attachment B.

These are only suggested field testing procedures and are not recommended for adoption by the Commission as part of an official meter accuracy requirement. It should be noted that, while socket and panel style meters may be more easily field tested, there are no field testing requirements in any certifications or standards.

Finally, the Commission directed the Program Administrators and the Metering Subcommittee to develop a plan for ensuring the accuracy of  $\pm 5\%$  accurate meters for participation under the EPBB incentive structure. Several inverter manufacturers involved in the Working Group have indicated intent to develop inverter-integrated meters capable of achieving  $\pm 2\%$  accuracy levels. The proposed certification requirements only test to the  $\pm 5\%$  accuracy levels, however. Since the ANSI C12.1-2001 test procedures cannot be performed on inverter-integrated meters, should the Commission decide to allow  $\pm 2\%$  accurate inverter-integrated meters under the PBI structure, the proposed certification requirements would need to be modified to test the more accurate inverter meters. Since the language in D.06-08-028 only allows for a “separate solar production meter<sup>3</sup>” for PBI systems, this would also require a modification to the original decision to implement.

At this time, the Working Group is not proposing such a modification to the program rules. We leave it up to the inverter manufacturers to demonstrate the benefits of more accurate inverter meters and to propose a modification to the decision. This information is only being included to inform the Commission and clarify existing program rules for interested parties.

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<sup>3</sup> CPUC Decision 06-08-028, Odering Paragraph 16, page 124.

**APPENDIX A**

<b>ANSI C12.1 Test Comparison Table</b>					<b>Other Applicable Certification Standards and Test Types</b>						<b>Review comments</b>	
<b>Accuracy Tests No. and Title</b>		<b>No Change</b>	<b>Modify</b>	<b>N/A</b>	<b>Certification Test Descriptions for Inverter Integral Meters</b>	<b>UL 1741</b>	<b>IEEE 1547</b>	<b>CEC / Sandia</b>	<b>Separate Test or NRTL</b>	<b>Type (T) Production (P) test</b>	<b>Series / Non-Series Test</b>	
#1	No Load		X		<p>Test shall be conducted with the inverter in a non-generating state having AC output circuit energized within the normal operating AC voltage range of the device and the metering subsystem operating. AC power reading(s) used to calculate energy shall be zero watts +/- 1% of the maximum output power rating of the inverter for the duration of the test. The power reading used to calculate energy must be recorded.</p> <p>Type test shall be conducted for a period of 10 minutes. Production test shall be conducted for a period of 10 seconds.</p> <p>Note: There is still a debate over the proper duration and form for this requirement. Primarily in the area of Time vs. # of Samples. One thought was proposed to allow an "either/or". Also, it was collectively determined that this was the appropriate test/stage to incorporate a loss-of-phase test to meet the intent of ANSI Test 14 (Independence of Elements).</p>				X	T, P	Non-Series	
#2	Starting Load			X	Not necessary; No mechanical meter load; Nil effect	---	---	---	---	---	Non-Series	
#3	Load Performance		X		Test meter at CEC/Sandia power levels. Compare inverter meter to reference meter. Power values shall be within +/-5% of the test reference meter. Current power levels are: 10, 20, 30, 50, 75, 100%. (May or may not need to state power levels if decided to reference CEC/Sandia)			Sec. 5.3 & 5.4		T	Non-Series	

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#4	Effect of Variation of Power Factor			X	Not necessary for inverters if they are certified by other standard / NRTL to operate at >.9 PF. (i.e. UL, IEEE, or CEC/Sandia); Scale table in ANSI C12.1 for inverters that are not certified for >.90 PF.; Need reference for applicable certification reference.	---	---	---	---	---	Non-Series
#5 or 5a	Effect of Variation of Voltage		X		Intent is to ensure that power readings are accurate at all operational voltages of the inverter. Meter should be tested at or near inverter minimum, nominal, and maximum voltages. Actual test voltages may be equal to those specified in UL 1741 & IEEE 1547 Utility Voltage and Frequency tests. Reference power level should be coordinated with CEC 20% test (CEC 5.3 & 5.4). Proposal is to determine reference power value at nominal voltage and at low & high line voltage, the power readings be within 2.5 percent of reference.		Sec. 5.2			T	Non-Series
#6	Effect of Variation of Frequency		X		Intent is to ensure that power readings are accurate at all operational frequencies of the inverter. Meter should be tested at or near inverter minimum, nominal, and maximum frequencies. Actual test voltages may be equal to those specified in UL 1741 & IEEE 1547 Utility Voltage and Frequency tests. Reference power level should be coordinated with CEC 20% test (CEC 5.3 & 5.4). Proposal is to determine reference power value at nominal frequencies and at low & high line frequencies, the power readings be within 2.5 percent of reference.		Sec. 5.3			T	Non-Series
#7	Equality of Current Circuits			X	N/A for inverters; Modify & scale for 5% on panel mounts	---	---	---	---	---	Non-Series
#8	Internal Meter Losses			X	N/A for inverters; Modify & scale for 5% on panel mounts	---	---	---	---	---	Non-Series
#9	Temperature Rise			X	Safety aspects of ANSI C12 test are covered by UL, IEEE, & CEC tests	Sec. 43	Sect. 5.1	Need Specific Sections	---	---	Non-Series

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#10	Effect of Register Friction			X	Solid State devices not affected by friction	---	---	---	---	---	N/A
#11	Effect of Internal Heating		X		Reference C12 test and generate our own table. All tests made at 23C Ambient +/- 5 degrees. 2 reference points. 100% rated power & 20% rated power (both +/-3%) 1st test condition 100% after 1/2 hour allowed deviation =2.5%. 2nd test @ 100% for 1 hour with 3.75% deviation. Shut off for 2 hours. Skip 3, 4, 5. Test 6 is 20% power with 2.5 deviation (immediate test). Test 7 is 100 at 2.5% deviation (immediate test).	Sec. 43	Sec. 5.1	Need Specific Sections		T	Non-Series
#12	Effect of Tilt			X	Solid State devices not affected by tilt. Inverter integral meters mounted at orientation(s) of inverter.	---	---	---	---	---	N/A
#13	Stability of Performance		X		Do test. Manufacturer Self-Certification OK.	Sec. 43	Sec. 5.1	Need Specific Sections		T	Non-Series
#14	Independence of Elements		X		Inverter cannot operate under the conditions this test is done due to anti-islanding (loss of phase, etc.). Add new test condition of loss of phase to Test 1. DC must be powered up with loss of phase. Phase choice up to mfr.					T	Non-Series
#15	Insulation		X		UL 1741 Hypot test is considered to be sufficient to address intent of ANSI C12.1 test #15.	Sec. 44				T	Series
#16	Voltage Interruptions		X		Conform to open-phase test and output short-circuit test in UL 1741. These tests are part of abnormal test series.	Sec. 47.3; 47.8	Sect. 5.9			T	Series
#17	Effect of High Voltage Line Surges		X		Similar to IEEE 1547.1 section 5.5.2.2? Test #17 & IEEE 1547 both reference IEEE C62.41 but 1547 uses C62.41.2 & C62.45. This item needs further review of referenced standards and discuss at next meeting. (BEW)		Sec. 5.5.2.2			T	Series
#18	Effect of External Magnetic Field			X	Look at IEEE 1547 - frequency range (FCC certification?)	---	---	---	---	---	Non-Series

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#19 or 19a	Effect of Variation of Ambient Temperature		X		Reference C12 test and generate our own table. Reference measurements made at 23C Ambient +/- 5 degrees. 2 reference points. 50% rated power & 20% rated power (both +/-3%). Soaking & operational time periods identical to Test 19. Minimum and maximum temperature test points are defined by manufacturer rated operating temperatures. Test shall not be required to be performed outside the manufacturer rated operating temperature range. Maximum allowable deviation from reference shall be +/- 2.5% @ high temp and +/- 5% at low temp.		Sec. 5.1.2.1	Need Specific Sections		T	Non-Series
#20	Effect of Temporary Overloads			X	Unable to isolate inverter from meter; Inverter damage certain by running this test; Other inverter tests cover safety and integrity aspects	---	---	---	---	---	Non-Series
#21	Effect of Current Surges in Ground Conductors			X	Met Labs says N/A. Working Group confirmed.	---	---	---	---	---	N/A
#22	Effect of Superimposed Signals			X	Met Labs says N/A. Working Group confirmed.	---	---	---	---	---	N/A
#23	Effect of Voltage Variation-secondary Time Base			X	N/A. Obsolete technology & application.	---	---	---	---	T	N/A
#24	Effect of Variation of Amb. Temp.-second. Time Base			X	N/A. Obsolete technology & application.	---	---	---	---	T	N/A
#25	Electrical Fast Transient/Burst		X		Where applicable FCC Part 15 Compliance certification is required, FCC Part 15 replaces Test #25.					T	Series

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#26	Effect of Radio Frequency Interference		X		Where applicable FCC Part 15 Compliance certification is required, FCC Part 15 replaces Test #26.					T	Non-Series
#27	Radio Frequency Conducted and Radiated Emission		X		Where applicable FCC Part 15 Compliance certification is required, FCC Part 15 replaces Test #27.					T	Non-Series
#28	Effect of Electrostatic Discharge (ESD)	X			Follow ANSI C12 procedure. This test references IEC 61000 Part 4-2 (1995).					T	Series
#29	Effect of Storage Temperature		X		Where IEEE 1547.1, Section 5.1.2.2 is performed, Section 5.1.2.2 replaces Test #29.		Sec. 5.1.2.2			T	Non-Series
#30	Effect of Operating Temperature		X		Where IEEE 1547.1, Sections 5.1.2.1 and 5.1.2.2 are performed per the requirements of Tests # 11, 19 & 29, Test #30 shall not be required. (Internal heating, Ambient temperature and storage temperature)					T	Series
#31	Effect of Relative Humidity		X	X	Inverter integral meters subject to inverter enclosure ratings and mfr. environmental specification for installation. Where Humidity Test as defined in UL 991 has been performed and passed, Test #31 shall not be required. (Additional reference: UL 1741, Section 31.7) NOTE: Comments by committee members indicate this test may be an N/A. Primary justification here is that the meters are solid-state devices and not subject to the same detrimental affects as electromechanical. Also mentioned is that the meter is an integral part of the inverter and therefore subject to the same environmental conditions as the balance of inverter components.		Sec. 31.7			T	Series

**APPENDIX A**

#32	Mechanical Shock			X	Unable to isolate inverter from meter; Probability of Inverter damage likely by running this test; Meter failure mode from this type of abuse is likely to result in DOA vs. "out of calibration". Probability of inverter damage is higher than out-of-calibration meter.	---	---	---	---	---	Non-Series
#33	Transportation Drop			X	Unable to isolate inverter from meter; Probability of Inverter damage likely by running this test; Meter failure mode from this type of abuse is likely to result in DOA vs. "out of calibration". Probability of inverter damage is higher than out-of-calibration meter.	---	---	---	---	---	Non-Series
#34	Mechanical Vibration			X	Unable to isolate inverter from meter; Probability of Inverter damage likely by running this test; Meter failure mode from this type of abuse is likely to result in DOA vs. "out of calibration". Probability of inverter damage is higher than out-of-calibration meter.	---	---	---	---	---	Non-Series
#35	Transportation Vibration			X	Unable to isolate inverter from meter; Probability of Inverter damage likely by running this test; Meter failure mode from this type of abuse is likely to result in DOA vs. "out of calibration". Probability of inverter damage is higher than out-of-calibration meter.	---	---	---	---	---	Non-Series
#36	Weather Simulation		X		Inverter integral meters subject to inverter enclosure ratings and mfr. environmental specification for installation. Additional research related to display/lens/light soaking aspect required.					T	N/A
#37	Salt-spray		X		Inverter integral meters subject to inverter enclosure ratings and mfr. environmental specification for installation.					T	N/A
#38	Rain Tightness		X		Inverter integral meters subject to inverter enclosure ratings and mfr. environmental specification for installation. UL 1741, Section 61 is the comparable standard to replace Test #38.	Sec. 61				T	N/A

## APPENDIX B

### Suggested Field Test Procedures for 5% Inverter-Integrated Meters

Since inverter-integrated meters cannot be removed from the inverter for testing, it is not possible to do a direct field test for meter accuracy. The 5% Meter Certification Working Group proposes the following options for performing an accuracy test on these devices:

1. Remove the Integrated meter / Inverter and send to a lab to test.
  - Pro: The unit accuracy is tested at one location.
  - Con: Unit is off site and off line for the duration of the test. Customer has no Solar at this time. Very few test locations and higher cost.
  
2. Test with a “Check” meter on site.
  - Pro: No need to remove Inverter from site. System is not off line. More Economical.
  - Con: The Field test will require a calibrated “Check meter” to stay in place over a period of several days (1 week).

The Working Group recommends option #2 as the most cost effective field test procedure. Under this option, a “Utility Grade” sub-meter with  $\pm 2\%$  accuracy is installed at the breaker panel or disconnect switch between the load panel and the inverter. This “Check Meter” should stay in place over the period of at least 1 week. This would accumulate enough kWh data from the same period from both the  $\pm 5\%$  inverter meter and the Check Meter. The data is then compared and verified.

The data can be verified by either of the following two methods:

$$\% \text{ of Error} = \text{Correct} - \text{Actual} / \text{Correct} \times 100$$

Correct = Check Meter reading

Actual =  $\pm 5\%$  inverter-integrated meter reading

$$\% \text{ of Accuracy} = \text{Indicated} - \text{True} / \text{True} \times 100$$

Indicated =  $\pm 5\%$  inverter-integrated meter reading

True = Check Meter reading

The Check Meter would need to be calibrated on a once-a-year schedule. It should be installed and run by a qualified testing agency such as a Meter Service Provider, a utility or other experienced entity.

**PG&E Gas and Electric  
Advice Filing List  
General Order 96-B, Section IV**

ABAG Power Pool	Douglass & Liddell	PG&E National Energy Group
Accent Energy	Downey, Brand, Seymour & Rohwer	Pinnacle CNG Company
Aglet Consumer Alliance	Duke Energy	PITCO
Agnews Developmental Center	Duke Energy North America	Plurimi, Inc.
Ahmed, Ali	Duncan, Virgil E.	PPL EnergyPlus, LLC
Alcantar & Kahl	Dutcher, John	Praxair, Inc.
Ancillary Services Coalition	Dynergy Inc.	Price, Roy
Anderson Donovan & Poole P.C.	Ellison Schneider	Product Development Dept
Applied Power Technologies	Energy Law Group LLP	R. M. Hairston & Company
APS Energy Services Co Inc	Energy Management Services, LLC	R. W. Beck & Associates
Arter & Hadden LLP	Exelon Energy Ohio, Inc	Recon Research
Avista Corp	Exeter Associates	Regional Cogeneration Service
Barkovich & Yap, Inc.	Foster Farms	RMC Lonestar
BART	Foster, Wheeler, Martinez	Sacramento Municipal Utility District
Bartle Wells Associates	Franciscan Mobilehome	SCD Energy Solutions
Blue Ridge Gas	Future Resources Associates, Inc	Seattle City Light
Bohannon Development Co	G. A. Krause & Assoc	Sempra
BP Energy Company	Gas Transmission Northwest Corporation	Sempra Energy
Braun & Associates	GLJ Energy Publications	Sequoia Union HS Dist
C & H Sugar Co.	Goodin, MacBride, Squeri, Schlotz &	SESCO
CA Bldg Industry Association	Hanna & Morton	Sierra Pacific Power Company
CA Cotton Ginners & Growers Assoc.	Heeg, Peggy A.	Silicon Valley Power
CA League of Food Processors	Hitachi Global Storage Technologies	Smurfit Stone Container Corp
CA Water Service Group	Hogan Manufacturing, Inc	Southern California Edison
California Energy Commission	House, Lon	SPURR
California Farm Bureau Federation	Imperial Irrigation District	St. Paul Assoc
California Gas Acquisition Svcs	Integrated Utility Consulting Group	Sutherland, Asbill & Brennan
California ISO	International Power Technology	Tabors Caramanis & Associates
Calpine	Interstate Gas Services, Inc.	Tecogen, Inc
Calpine Corp	IUCG/Sunshine Design LLC	TFS Energy
Calpine Gilroy Cogen	J. R. Wood, Inc	Transcanada
Cambridge Energy Research Assoc	JTM, Inc	Turlock Irrigation District
Cameron McKenna	Luce, Forward, Hamilton & Scripps	U S Borax, Inc
Cardinal Cogen	Manatt, Phelps & Phillips	United Cogen Inc.
Cellnet Data Systems	Marcus, David	URM Groups
Chevron Texaco	Matthew V. Brady & Associates	Utility Resource Network
Chevron USA Production Co.	Maynor, Donald H.	Wellhead Electric Company
City of Glendale	MBMC, Inc.	White & Case
City of Healdsburg	McKenzie & Assoc	WMA
City of Palo Alto	McKenzie & Associates	
City of Redding	Meek, Daniel W.	
CLECA Law Office	Mirant California, LLC	
Commerce Energy	Modesto Irrigation Dist	
Constellation New Energy	Morrison & Foerster	
CPUC	Morse Richard Weisenmiller & Assoc.	
Cross Border Inc	Navigant Consulting	
Crossborder Inc	New United Motor Mfg, Inc	
CSC Energy Services	Norris & Wong Associates	
Davis, Wright, Tremaine LLP	North Coast Solar Resources	
Defense Fuel Support Center	Northern California Power Agency	
Department of the Army	Office of Energy Assessments	
Department of Water & Power City	OnGrid Solar	
DGS Natural Gas Services	Palo Alto Muni Utilities	